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(54) Title: FLAVONOID ALDEHYDES AND USE IN PAINT

(57) Abstract

Methods and compositions are provided based upon flavonoid aldehydes, which find use as antimicrobials for paint and wood preservatives. The compositions can be added prior to shipment of the paint or wood preservative. Methods of preventing microbial contamination of a coated substrate are also provided. The substrate includes walls, tiles, sidewalks, and boat hulls.

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FLAVONOID ALDEHYDES AND USE IN PAINT

INTRODUCTION

Field of the Invention

This invention relates to flavonoid aldehydes as biocides in paints and wood preservative products for use in, and on the surfaces of, homes, boats, offices and industrial buildings.

Background

Biocides are required in many paint and wood preservative formulations to prevent microbial degradation during shipment, storage or use. Biocides are also required in these formulated products to help protect a substrate subsequently coated with these formulated products from harmful microorganisms such as bacteria and fungi and the like. Biocides used in paint products may be grouped into three major classes: preservatives, mildewicides and antifoulants. Preservatives are widely used in water-based paint systems to prevent in-can bacterial and fungal degradation during storage and shipment. They are particularly useful in latex systems such as synthetic rubber, polyacrylate, and natural rubber latexes. Mildewicides are employed to prevent degradation of the dried paint films and underlying substrate by microorganisms. Antifoulant paints are used to prevent the growth of organisms on the hulls of both commercial and pleasure boats. The attachment of such organisms decreases the operating efficiency of the boats and increases their maintenance costs.

Mercurial-type biocides have been widely used as both preservatives and mildewicides in paints. They have excellent performance in both functions in many situations. They offer fast kill time and can control high levels of bacterial contamination. Unfortunately, they are hazardous to handle and may present environmental problems. Thus, their use may be limited to certain applications. Various nonmercurial preservatives and mildewicides have been increasingly considered as substitutes for mercurial compounds.

A wide variety of biocides have been tried as marine antifoulants, but the marketplace has been dominated by formulations of cuprous oxide and organotin compounds. Cuprous oxide has been popular because it is efficient, relatively economical, and is specified in many military antifouling paint formulations as the exclusive biocide. However, this chemical causes microporosity in the paint film, which adversely affects efficiency, and it limits the paint colors which can be formulated to those of a dark reddish brown. The use of organotin compounds has been growing in recent years; however, these compounds are more expensive than cuprous oxide and also more difficult to incorporate into paint formulations. Furthermore, they do not leach out completely during use so that when ships are sandblasted, the disposal of the resulting contaminated sand poses difficulties. However, paint formulations containing organotins yield uniform, tight films without the microporosity problems associated with those formulated with cuprous oxide and may be formulated in a wide variety of bright or light colors. For these latter reasons, they are widely used on pleasure boats. Since both cuprous oxide and organotin compounds present technical or environmental problems, there is a need for new and better antifoulant paint biocides.

Biocides also are employed as wood preservative products in order to prevent deterioration of wood products that are exposed to conditions which promote microbial growth and decay. For example, utility poles, cross ties, piling timbers, freshly milled lumber and fence posts as well as wood chip piles used in pulp manufacture require the incorporation of biocides to stop or control fungal attachment. In the past, two classes of biocides have been employed as wood preservatives. One class is oil-borne preservatives (*e.g.*, creosote and pentachlorophenol) while the second class is water-borne salts (*e.g.*, mixtures of inorganic compounds such as copper, chromium, arsenic and zinc salts). The oil-borne preservatives have been the most widely used biocides for wood preservation. However, products treated with these mixtures may have messy oily surfaces. Also both creosote and pentachlorophenol have been objected to as being environmentally hazardous. The water-borne salts are also toxic chemicals which are dissolved in water and injected into wood products where they become bound to or within the wood. These salts have certain advantages over the oil-borne treatments. They leave a cleaner surface that may be more readily painted. Also, their water soluble

characteristics provide savings in solvent costs. However, the use of chromium and arsenic salts in particular presents environmental problems.

Mosses are a nuisance in horticultural and landscape maintenance. More importantly, in certain geographic zones favoring moss growth on surfaces frequented by people (*e.g.*, stairs, walkways, paths, decks, patios), there is an ongoing concern about slip and fall injuries. Particular interest has been expressed concerning the safety of senior citizens in outdoor areas of nursing and rehabilitation centers where the results of such slip and fall accidents are of more medical (particularly orthopedic) concern. Products on the market for control of moss include zinc chloride and ferric sulfate. Zinc chloride solutions have several disadvantages. They may cause injury to the respiratory tract; they are corrosive to the eyes resulting in severe damage which may be followed by blindness; on skin contact they will severely irritate or burn the skin; and upon swallowing, they are extremely corrosive to the mouth and throat, where they burn the tissue, and in sufficient quantities they can cause death to the animal. Ferric sulfate is corrosive to the eye and is listed as toxic to aquatic life.

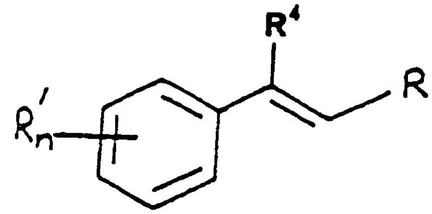
It therefore is of interest to develop biocides for use in paint and wood preservatives which do not pose health and/or environmental hazards.

Relevant Literature

Antifouling paint is disclosed in USPN 4,313,860. Mildew resistant paint compositions are disclosed in USPN 5,073,582. Skin diseases and contact sensitivity in house painters using water-based paints, glues and putties is described in Fischer, *et al.*, (1995) *Contact Dermatitis* 32:39-45.

SUMMARY OF THE INVENTION

The present invention provides compositions and methods for controlling pathogenic organisms using flavonoid aldehydes in paint and wood preservatives. The method includes the step of including an antipathogenic agent in the paint or wood preservative formulation in an amount sufficient to control growth of target pathogenic organisms. The growth modulating product has a formula shown in (1) below:



(1)

wherein R represents $-CH_2OH$ or $-CHO$; n is an integer from 0 to 3; each R_1 independently represents OH or an organic substituent containing from 1 to 10 carbon atoms and from 0 to 5 heteroatoms, wherein the total number of carbon and heteroatoms in all R_1 substituents of said compound is no more than 15, and R^4 represents hydrogen or an organic constituent containing from 1 to 10 carbon atoms. These compounds include natural compounds such as cinnamaldehyde, coniferyl aldehyde, and closely related compounds. Also of interest are alpha substituted aldehydes, such as α-hexyl cinnamic aldehyde (HCA). The method finds use in treating ornamentals and agricultural crops for pathogenic organisms.

DESCRIPTION OF THE SPECIFIC EMBODIMENTS

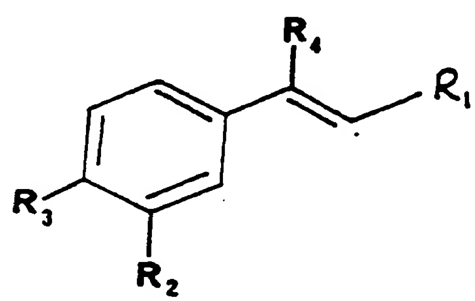
Paint and wood preservatives substantially free of pathogenic organisms such as fungi and bacteria are provided together with a method to biocontrol pathogen infestations on painted or treated surfaces using flavonoid aldehydes. By "biocontrol" is intended control of pathogens via direct antipathogenic activity. A fungus and/or bacteria colonizing formulation or coated substrate such as a roof and roof shingles, barns, boat hulls, railroad ties, tree trunks, wooden "jungle gyms," decks, docks, walkways, stairs, wooden patios, or wharves with brick surfaces, are contacted with a paint or preservative containing a flavonoid aldehyde. By "colonizing" is intended association of a microorganism or insect with a surface or with a paint or preservative formulation. The flavonoid aldehydes can be isolated from a natural source, be wholly or partially synthetic, or be produced by recombinant techniques.

The method of the subject invention is carried out by adding an effective pathogen-inhibiting amount of a compound of the invention to a paint or preservative formulation. The compound preferably is added at the time of placing the formulation in a shipping container, but can be added immediately prior to use of the

product. The amount of antipathogenic agent that is added depends to some extent upon the paint or preservative formulation and the specific compounding used and therefore is empirically determined for best results. By "antipathogenic" is intended controlling the growth of pathogens and can involve killing the pathogen and/or slowing or arresting its proliferation.

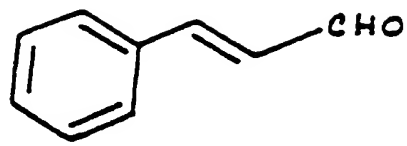
The compounds of the present invention offer several advantages over those currently in use. They possess good antimicrobial activity and are not incompatible with components of conventional paint and wood preservative products. The compounds also are non-volatile, hydrolytically stable, thermally stable, and depending upon their chemical structure, may be soluble in water and organic solvents. Furthermore, generally they form no undesirable colors in the paint and wood preservative formulations or in the resulting dried films. Still further, they are cost competitive with known biocides used in various paints and wood preservative products while having low or no toxicity toward humans and wildlife. The present invention also overcomes the problem of migration of previously available preservatives by bonding the bioactive compounds to the wood.

A preferred preservative compound is shown in formula (2) below:



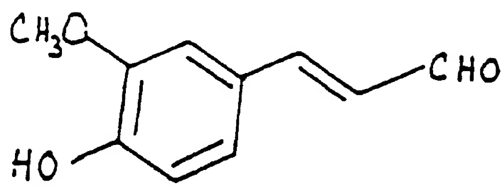
(2)

wherein R_1 represents-CHO, R_2 represents-OH or an organic substituent containing from 1 to 10 carbon atoms, R_3 represents a methoxy group or organic substituent containing from 1 to 10 carbon atoms, and R_4 represents a hydrogen or an organic substituent containing from 1 to 10 carbon atoms. Of particular interest are flavonoid aldehydes, particularly aromatic aldehydes. Examples of aromatic aldehydes of use in the present invention are cinnamic aldehyde ((3) below):



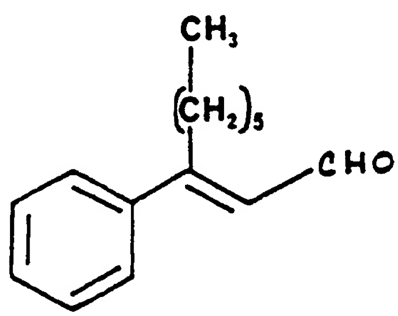
(3)

and coniferyl aldehyde ((4) below):



(4)

Other compounds of interest include analogs of the compound of formula (1) such as compounds substituted at the alpha position with an alkyl, such as a hexyl group, or a branched alkyl group such as an amyl group. Generally the group at the alpha position is from C-5 to C-10. Such compounds include alpha hexyl cinnamaldehyde and alpha amyl cinnamaldehyde. The chemical structure of alpha-hexylcinnamic aldehyde (HCA) is shown in (5) (below).



(5)

The Chemical Abstracts Service (CAS) name of HCA is 2-(phenylmethylene) octanal and the CAS Registry Number is [101-86-0]. The compound is also described by the chemical name of 2-hexyl-3-phenyl-2-propenal. The formula of the compound is $C_{15}H_{20}O$ and the molecular weight is 216.3. HCA is a low to moderately volatile compound, having a vapor pressure of 70 x 10^{-5} mm Hg at 25°C. Its parent compound, cinnamic aldehyde, has a vapor pressure approximately 40 times higher (2970 x 10^{-5} mm Hg at 25°C). (Reifenrath, W.G. (1995) *Volatile Substances. Cosmetics and Toiletries*, 110: 85-93).

The aromatic and aliphatic aldehydes of the subject invention can be prepared by various synthetic methods known to those skilled in the art. For example, *see*, J. March, ed., Appendix B, *Advanced Organic Chemistry: Reactions, Mechanisms, and Structure*, 2nd Ed., McGraw-Hill, New York, 1977. Cinnamaldehyde can be prepared synthetically, for example, by oxidation of cinnamyl alcohol (Traynelis *et al., J. Am. Chem. Soc.* (1964) 86:298) or by condensation of styrene with formylmethylaniline (Brit. patent 504,125). The subject aldehydes also can be obtained by isolation from natural sources. For example, cinnamaldehyde can be isolated from woodrotting fungus, *Stereum subpileatum*. Birkinshaw *et al.*, *Biochem. J.* (1957) 66:188.

HCA can be synthesized as described, for example, in USPN 5,055,621. On a laboratory scale, HCA can be synthesized by reaction of benzaldehyde with octanal under a nitrogen atmosphere (aldol condensation) (Personal Communication, Eric Walborsky, Firmenich Chemical Manufacturing Center, Port Newark, New Jersey). The reaction is conducted in a stirred flask charged with methanol, 309 ppm diphenylamine, potassium hydroxide and benzaldehyde. Following the slow addition of octanal, the reaction mixture is brought to a pH of 7.5-9.5 with acetic acid. Following evaporation of methanol and wash of the reaction mixture with water, the organic phase is transferred to a distillation unit. Approximately 20-24% of the pot charge is removed as benzaldehyde and "lights", with the remaining distillate constituting alpha-hexylcinnamic aldehyde "heart cut." The "heart cut" is subjected to an additional fractionation, in which 1-5% (by weight) of the material is removed in "light" fractions, depending upon odor evaluation. The final product is a light yellow oil having a specific gravity of 0.955-0.965 at 20°C, a refractive index of 1.548-1.562 at 20°C, a boiling point of 305°C at 1 atmosphere, and a melting point of 26°C.

HCA also can be obtained from Firmenich; their product is composed principally of the (E)-cis isomer (93.8% maximum), and the (Z)-trans isomer (6% maximum). Among minor components is the self aldol condensation product of octanal (1-1.5% (Personal Communication, June Burkhardt, Firmenich, Plainsboro, New Jersey). The commercial product is stabilized with the addition of 0.04% 2, 6-di-tert-butyl-p-cresol (butylated hydroxytoluene or BHT), which serves as an anti-oxidant (Technical Data Sheet, Hexylcinnamic aldehyde 907600, Revision 853,

Firmenich Inc., Plainsboro, New Jersey). HCA can be isolated from rice where it has been reported to occur naturally. (Givaudan-Roure Index, Givaudan-Roure Corporation, Clifton, New Jersey, 1994, p. 89).

The compounds can be used by incorporating an effective paint preservative amount of the compound into a paint or wood preservative. By "an effective paint preservative amount" is intended any amount which will prevent or control degradation of the paint. In-can degradation of paints is often caused by gram-positive bacteria such as *Bacillus cereus* and *Staphylococcus aureus* or gram-negative bacteria such as those of the *Pseudomonas* or *Xanthomonas* classes. This degradation of the paint ingredients results in viscosity loss or generation of offensive odors.

Generally, paint preservatives are employed in aqueous-based paint systems such as latex systems. Solvent-based paints usually do not require a preservative since the nonaqueous formulation will not support fungal and/or bacterial growth. In-can preservatives are fungicidal and/or bactericidal and their killing action preferably is rapid to prevent production of enzymes by the microorganisms which are actually the cause of the latex paint destruction.

When the present bioactive compounds are employed as paint preservatives, it is usually desirable to add them to the paint formulation in the same manner as other ingredients are incorporated. It is preferred to incorporate them as a substitute for substantially all of the non-bioactive non-paint components in the paint formulation. The actual amount of preservative used varies depending upon many parameters. Generally, it is preferred to employ from about 0.5 to 5 volume % of a compound of formula (1) as part of a total paint formulation for this purpose.

The compounds of the subject invention also find use for the prevention and/or killing of mildew (mildewicides). Accordingly, the term "effective mildewicidal amount" is intended to include any amount which will kill or control the growth of mildew-causing microorganisms. Mildew or mold causing microorganisms vary according to the exposure environment. *Aureobasidium pullulans* is the most commonly found species in temperate and colder climates. Tropical and subtropical conditions favor the growth of microorganisms of the classes *Aureobasidium*, *Aspergillus* and *Penicillium* as well as the algae *Pieurococcus virides*. The effective mildewicidal amount is varied empirically based up changes in the parameters of the environment and the substrate having the compounds of the subject invention

incorporated therein. Generally, it is preferred to employ from about 0.5 to 5 volume % of a compound shown in formula (1) as part of a total paint formulation.

Another use for the subject compounds is as an antifoulant. An effective antifoulant amount of one or more of the compounds of formula (1) is incorporated into a hull coating formulation. By the term "effective antifouling amount" is intended any amount which will prevent or control fouling on the hull. Fouling organisms include plant forms such as algae and animal forms such as those of the classes Anthropeda, Coelenterata and Mollusca. The green algae Enteromorpha is the organism most often found on the hulls of large ships. The effective antifouling amount will vary because of changes in the parameters of the environment and the substrate on which it is applied to the hulls. Generally, it is preferred to employ from about 0.5 to 5 volume % of the active moiety shown in formula (1) as part of a total paint formulation for this purpose.

An additional use of the subject formulation is as a wood preservative. An effective wood-preserving amount of one or more of these compounds is incorporated into a wood treatment product. The term "effective wood-preserving amount" is intended to include an amount of the compound which prevents or controls degradation of the wood product to which it is applied. Wood products not in water are subject to two forms of fungal attack, surface attack (*e.g.*, soft rot) and internal attack (*e.g.*, white and brown rots). *Fungi imperfecti* and *Ascomycetes* are the major cause of soft rot and the *Basidiomycetes* class of fungi is the major cause of internal attack. White rots attack the lignin and brown rots attack the cellulose. The commonly known dry rot is a brown rot. Also, wood products exposed to seawater are attacked by marine organisms such as *Pholads*, *Teredo*, and *Limnoria tripunctata*. The effective amount of compound employed in this application is empirically determined based upon parameters which include the specific preserving compound(s) employed, the type of wood product to be protected, and the type of environment the wood product is exposed to. Generally, it is preferred to employ from about 0.5 to 5 volume % of the active moiety shown in formula (1) as part of a total wood preservative formulation.

The biocides of the present invention can be added to the wood products by either pressure or nonpressure impregnation. If pressure impregnation is employed, air, hydrostatic pressure or vacuum methods, or combinations thereof, can be used.

If nonpressure impregnation of wood is desired, dipping, spraying, brushing or the like can be used.

The bioactive compounds of the present invention can be either added directly to cellulosic materials such as the wood products in a preformed state, or the compounds of formula (1) can be added to, for example, bound to a cellulose binding protein. In this latter case, the bioactive compounds bond to the polysaccharide structure of the cellulosic material (*e.g.*, wood, paper and the like) upon contact. Paper products can be treated to make a mildew-resistant paper, cardboard boxes or the like using the flavonoid compound - polysaccharidase binding conjugate. A sufficient portion of a cellulose binding domain up to the full length cellulose can be used when the target polysaccharide is a cellulose. The preparation of cellulose binding domains is described in U.S. Patent Nos. 5,340,731; 5,202,247 and 5,166,317. Binding proteins from scaffold proteins also can be used. See Shoseyev et al. (PCT application EP/0594/04132). The conjugate can be prepared with or without a cleavable bond using methods known to those skilled in the art.

Paint and wood preservative products which may contain the biocidal compositions of the invention as preservatives and mildewicides include such as latex and solvent interior and exterior paints, coatings for new and existing architectural structures. Other paint products include industrial finishing products such as interior and exterior maintenance coatings and marine antifouling paints.

The following examples are offered by way of illustration and not by way of limitation.

EXAMPLES

Materials and Methods

The chemicals used in the examples given below were obtained from the following sources: cinnamic aldehyde, Spectrum Chemical Company, N.J.; coniferyl aldehyde, APIN Chemical, U.K.; Tween 80 and sodium bicarbonate Spectrum Chemical Company, Gardena, Ca. Concentrations are given as the concentration of the indicated solution before dilution.

Example 1

Fungal and Algal Repellency Test of Compounds

The bioactive compounds are tested for fungal and algal repellency. Microscope slides are used as the substrates in both cases. One half of each slide is coated on one side with a film of polymer containing the active agent to be tested, while the other half of the slide is not treated with the active agent. The total slide is exposed to the challenge of either fungi or algae with the expectation that the half of the slide containing the active agent will prevent growth of the challenging organism, while the untreated half will not.

In the fungal test, the slide is placed on the surface of an agar plate which is seeded with fungi. After incubation for about 14 days, the slide is examined for extent of growth or lack thereof on the treated surface of the slide. Since leaching of the active agent would create an undesirable zone-of-inhibition outside the perimeter of the treated surface of the slide, no growth on the treated surface along with a small, or no, zone of inhibition is the desired result.

In the algal test, the slide is immersed in a nutrient broth which has been inoculated with the algae *Pleurochloris pyrenoidosa*. After an incubation for 30 days (under light) and a water rinse, the slide is examined microscopically and the extent of algal attachment is noted. Total lack of attachment on the treated surface is the desired result. Additional information is obtained by comparing the extent of growth of algae throughout the broth. Significant leaching of the active agent from the treated surface would inhibit growth in the broth as well as on the treated surface.

Example 2

Paint Mildewicide Tests

The test procedure is followed exactly from the following published procedure: R.A. Zabel and W.E. Horner, *Journal of Coatings Technology*, 53, 33-37, (1981), except that the organism *Aureobasidium pullulans* M30-4 is used, isolated from mildewed exterior latex paint. Duplicates are run in each case. Two separate tests are run for slightly different time periods.

Example 3

Wood Preservation Testing

This aspect of the present invention extends the utility of the above described antimicrobial compounds to the wood preservation area. Two general techniques are shown. In one, a solution of the compound is applied to the wood directly. In the second, a solution of compound bound to a cellulose binding protein is applied to the wood.

Eight (about 2.5 cm x 2.5 cm x 0.5 cm) weighed pine wood blocks are placed in a dish and a 5-6 mm Hg vacuum applied for 30 minutes. Two solutions are prepared, one containing a compound of formula (1) and the second a compound of formula (1) bound to a cellulose binding protein. While still under vacuum, each solution is added to a dish and the wood blocks are submerged in one of the two solutions. After soaking for 30 minutes the wood blocks are removed from the solutions, excess compound is wiped off and the blocks are heated at 75° C. for 16 hours. After cooling to room temperature the blocks are weighed and analyzed to determine the distribution of compound throughout the wood chip.

Example 4

Wood Rot Test

The test procedure is based upon the following published procedure: H.P. Sutter, *International Biodeterioration Bulletin*, 14 (3), 95-99 (1978). The organisms employed are *Coniophora puteana* ATCC 36336 and *Lentinus lepideus* ATCC 12653 (a creosote-resistant fungus). Duplicates are run in each case. The growth of brown rot (cellulose-degrading) fungi on pine blocks after 25 days at 28° C. is evaluated as:

Growth Key
0 - no growth
1 - slight growth
2 - moderate growth
3 - heavy growth
4 - very heavy growth

Four (2.5 cm x 2.5 cm x 0.5 cm) print wood blocks are surface treated with either a wood preservative comprising a test concentration of a compound according to formula (1) or a commercial wood preservative. The wood blocks are brush coated on all surfaces and in some cases multiple coats are applied. Pressure treatment is not used. These present examples correspond to what a consumer would do to apply a wood preservative. The amount of biocide applied to each wood block is calculated by determining the weight increase of each wood block after treatment and calculating the biocide present in the weight increase.

Example 5

Antimicrobial Testing

Biofunctional compounds are tested in a standard Minimum Inhibitory Concentration (MIC) test against 8 different bacteria and 8 different fungi. Also tested in this MIC test are Tween 80 (2%), $NaHCO_3$ (6%) and Tween 80 (2%) plus $NaHCO_3$ (6%) as blanks.

The organisms included in the MIC test are:

Bacteria:

1 - *Pseudomonas aeruginosa* ATCC 9028;
2 - *Pseudomonas aeruginosa* (pyrithione resistant);
3 - *Enterobacier aerogenes* ATCC 13048;
4 - *Staphylococcus aureus* ATCC 6538;
5 - *Pseudomonas syriugae* ATCC 19310;
6 - *Pseudomonas phaseolicola* ATCC 11355;
7 - *Xanthomonas vesiculoria* ATCC 11551;
8 - *Xanthomonas phaseoli* ATCC 19315; and

Fungi:

1 - *Aspergillus niger* ATCC 16404;
2 - *Trichophyton mentagrophytes* ATCC 9533;
3 - *Candida albicans* ATCC 10231;
4 - *Helminthosponium oryzac* ATCC 34393;
5 - *Fusearium oxysporum* ATCC 15643;
6 - *Glomerella augulata* ATCC 10593;
7 - *Aeternaria solani* ATCC 11078;
8 - *Rhizoclonia solani* ATCC 28268.

Example 6

Bryophytacide Activity of Flavonoid Aldehyde

Bryophyta (moss) bioassay studies were carried out as follows: fifteen 9 cm plastic petri dishes were lined with Whatman filter paper discs (7.5 cm). Three ml water were pipetted onto each filter paper disc. Mosses were placed in groups of five; each moss section was about 3.5 cm x 3.5 cm. Two ml of test solution were sprayed as a fine mist (Gilmour sprayer) from a distance of 10 cm. and the petri dishes placed on a table at ambient room temperature and observed at 24, 48 and 60 hours. The area of desiccation was measured at each observation time point. See Table 1 (below) for results.

In a second set of experiments, the above procedure was repeated with *Dicranum* moss using a single concentration of cinnamic aldehyde (2%) in a vehicle of 2% Tween 80 and 6% $NaHCO_3$ as compared to the individual components of the formulation. See Table 2 for results.

Table 1
Bryophyta (Moss)
Percent of Desiccation (over time)

Moss	Formulation	0	24 hrs.	48 hrs.	60 hrs.
Dicranum	F1	0	15	40	90
	F2	0	10	40	80
	F3	0	15	50	85
	F4	0	5	15	25
	F5	0	6	18	26
Spagnum (Bog Moss)	F1	0	20	60	90
	F2	0	25	55	75
	F3	0	20	60	85
	F4	0	8	12	20
	F5	0	9	12	22
Woodland	F1	0	20	60	85
	F2	0	10	40	70
	F3	0	20	50	80
	F4	0	10	15	20
	F5	0	12	18	28

F1 Cinnamic aldehyde (2%) in 2% Tween 80, 6% $NaHCO_3$.
F2 Saponin (10° Brix) 0.86 ml conc. diluted in 50 ml water.
F3 [F1 + F2].
F4 -CONTROL H_2O.
F5 2% Tween 80, 6% $NaHCO_3$.

Table 2

Moss
Percent dessication at 60 hours

Formulation	Percent Desiccation
Cinnamic aldehyde (2%)	70
T80 (2%)	10
$NaHCO_3$ (6%)	20
T80 + $NaHCO_3$ (2% + 6%)	25
F1	90
F4	10

The most effective formulation tested was 2% cinnamic aldehyde in 2% Tween 80 and 6% $NaHCO_3$; moss so treated showed 90% desiccation (*Dicranum* and Bog Moss) and 85% desiccation (Woodland Moss) at 60 hours. Cinnamic aldehyde (2%) in water produced 70% desiccation of *Dicranum* Moss at 60 hours. Saponin (1:60 in H_2O) 10° Brix caused 80%, 75% and 70% desiccation in *Dicranum*, Bog Moss and Woodland Moss, respectively. The combination of cinnamic aldehyde (2%) in vehicle and saponin (1:60 in H_2O) 10° Brix was more effective than saponin (1:60 in H_2O) alone, but less effective than 2% cinnamic aldehyde in vehicle.

Example 8

Formulation for Interior Latex Flat Paint

A latex paint formulation is mixed according to the proportions in Table 3, below.

Table 3

Latex Paint Formulation

Ingredient	Pounds	Gallons
Water	297.18	35.63
Propylene Glycol	35.00	4.05
Cellosize ER-4400	3.5	0.30
Kathon LX 1.5%	1.7	0.20
Drewplus L-422	2.0	0.27
Tanol 731	7.0	0.76
Triton N-101	2.0	0.23
AMP-95	2.8	0.36
Ti-Pure R-931	200.0	6.6
Optiwhite	75.0	4.09
Duramite	96.97	4.31
Ucar 379	265.50	29.35
Texanol	13.0	1.65
2.5% Cellosize ER-4400	100.0	11.92
Totals:	1103.75	100.00

Cinnamic aldehyde is substituted for Kathon and propylene glycol in various percentages.

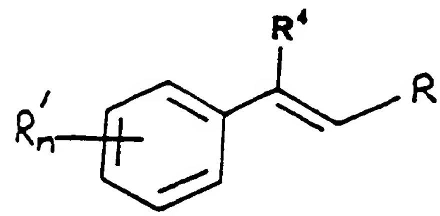
One gallon batches are produced and stored in sealed one gallon paint pails. At 30, 60, 120 and 180 days, lids are removed and the paint compared to commercial batches. Inspection for molds, skimming and settling is conducted. Test paints also are compared to commercial flat latex on wood surfaces over the same time frame. Inspections are made for mold and general coating deterioration.

All publications and patent applications mentioned in this specification are indicative of the level of skill of those skilled in the art to which this invention pertains. All publications and patent applications are herein incorporated by reference to the same extent as if each individual publication or patent application was specifically and individually indicated to be incorporated by reference.

The invention now having been fully described, it will be apparent to one of ordinary skill in the art that many changes and modifications can be made thereto without departing from the spirit or scope of the appended claims.

CLAIMS

1. A paint or wood preservative formulation comprising one or more bioactive compounds having the formula



(1)

wherein R represents $-CH_2OH$ or $-CHO$; n is an integer from 0 to 3; each R_1 independently represents -OH or an organic substituent containing from 1 to 10 carbon atoms and from 0 to 5 hetero atoms wherein the total number of carbon and hetero atoms in all R_1 substituents of said compound is no more than 15; and R_4 represents a hydrogen or an organic substituent containing from 1 to 10 carbon atoms.

2. The formulation of claim 1, wherein said bioactive compound is cinnamic aldehyde, coniferyl aldehyde, or alpha hexyl cinnamic aldehyde.

3. The formulation of claim 1 or 2, comprising 0.5 to 5 vol. % of the bioactive compound.

4. A process for preserving paint formulations susceptible to bacterial degradation, said method comprising:

incorporating into said paint formulation an effective paint preserving amount of at least one bioactive compound having the formula (1), wherein R represents $-CH_2OH$ or $-CHO$; n is an integer from 0 to 3; each R_1 independently represents -OH or an organic substituent containing from 1 to 10 carbon atoms and from 0 to 5 hetero atoms wherein the total number of carbon and hetero atoms in all R_1 substituents of said compound is no more than 15; and R_4 represents a hydrogen or an organic substituent containing from 1 to 10 carbon atoms.

5. A process for controlling or preventing fouling on a hull of a boat, comprising treating said hull with the formulation of any one of the claims 1-3.

6. Use of one or more compounds having the formula (1) wherein R represents $-CH_2OH$ or $-CHO$; n is an integer from 0 to 3; each R_1 independently represents -OH or an organic substituent containing from 1 to 10 carbon atoms and

from 0 to 5 hetero atoms wherein the total number of carbon and hetero atoms in all R_1 substituents of said compound is no more than 15; and R_4 represents a hydrogen or an organic substituent containing from 1 to 10 carbon atoms as a biocide in paint and/or wood preservative products.

7. Use of one or more compounds having the formula (1), wherein R represents $-CH_2OH$ or -CHO; n is an integer from 0 to 3; each R_1 independently represents -OH or an organic substituent containing from 1 to 10 carbon atoms and from 0 to 5 hetero atoms wherein the total number of carbon and hetero atoms in all R_1 substituents of said compound is no more than 15; and R_4 represents a hydrogen or an organic substituent containing from 1 to 10 carbon atoms as a preservative for paint.

8. Use of one or more compounds having the formula (1) wherein R represents $-CH_2OH$ or -CHO; n is an integer from 0 to 3; each R_1 independently represents -OH or an organic substituent containing from 1 to 10 carbon atoms and from 0 to 5 hetero atoms wherein the total number of carbon and hetero atoms in all R_1 substituents of said compound is no more than 15; and R_4 represents a hydrogen or an organic substituent containing from 1 to 10 carbon atoms as a mildewicide in paint and/or wood preservative products.

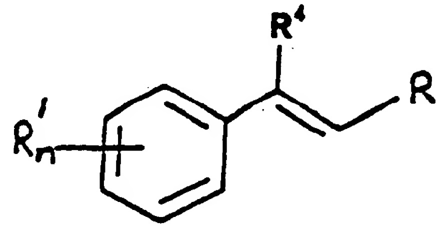
9. Use of one or more compounds having the formula (1), wherein R represents $-CH_2OH$ or -CHO; n is an integer from 0 to 3; each R_1 independently represents -OH or an organic substituent containing from 1 to 10 carbon atoms and from 0 to 5 hetero atoms wherein the total number of carbon and hetero atoms in all R_1 substituents of said compound is no more than 15; and R_4 represents a hydrogen or an organic substituent containing from 1 to 10 carbon atoms as an antifoulant in paints and/or wood preservative products.

10. Use according to any one of the claims 6-9 wherein the compound having formula (1) is cinnamic aldehyde, coniferyl aldehyde, and/or alpha hexyl cinnamic aldehyde.

AMENDED CLAIMS

[received by the International Bureau on 20 August 1996 (20.08.96); original claims 1, 4, 6, 7 and 9 amended; new claims 11-16 added; remaining claims unchanged (4 pages)]

1. A paint or wood preservative formulation comprising one or more bioactive compounds having the formula



(1)

wherein R represents $-CH_2OH$ or -CHO; n is an integer from 0 to 3; each R^1 independently represents -OH or an organic substituent containing from 1 to 10 carbon atoms and from 0 to 5 hetero atoms wherein the total number of carbon and hetero atoms in all R^1 substituents of said compound is no more than 15; and R^4 represents a hydrogen or an organic substituent containing from 1 to 10 carbon atoms; provided that when R is -CHO, R^4 is hydrogen, and n=1, R^1 is not o-methoxy; further provided that said formulation does not include a heat resistant clay material or a copper-based component.

2. The formulation of claim 1, wherein said bioactive compound is cinnamic aldehyde, coniferyl aldehyde, or alpha hexyl cinnamic aldehyde.

3. The formulation of claim 1 or 2, comprising 0.5 to 5 vol. % of the bioactive compound.

4. A process for preserving paint formulations susceptible to bacterial degradation, said method comprising:

incorporating into said paint formulation an effective paint preserving amount of at least one bioactive compound having the formula (1), wherein R represents $-CH_2OH$ or -CHO; n is an integer from 0 to 3; each R^1 independently represents -OH or an organic substituent containing from 1 to 10 carbon atoms and from 0 to 5 hetero atoms wherein the total number of carbon and hetero atoms in all R^1 substituents of

said compound is no more than 15; and R^4 represents a hydrogen or an organic substituent containing from 1 to 10 carbon atoms; provided that when R is -CHO, R^4 is hydrogen, and n=1, R^1 is not o-methoxy; further provided that said formulation does not include a heat resistant clay material.

5. A process for controlling or preventing fouling on a hull of a boat, comprising treating said hull with the formulation of any one of the claims 1-3.

6. Use of one or more compounds having the formula (1) wherein R represents $-CH_2OH$ or -CHO; n is an integer from 0 to 3; each R^1 independently represents -OH or an organic substituent containing from 1 to 10 carbon atoms and from 0 to 5 hetero atoms wherein the total number of carbon and hetero atoms in all R^1 substituents of said compound is no more than 15; and R_4 represents a hydrogen or an organic substituent containing from 1 to 10 carbon atoms; provided that when R is -CHO, R^4 is hydrogen, and n=1, R^1 is not o-methoxy; further provided that said formulation does not include a heat resistant clay material, as a biocide in paint and/or wood preservative products.

7. Use of one or more compounds having the formula (1), wherein R represents $-CH_2OH$ or -CHO; n is an integer from 0 to 3; each R^1 independently represents -OH or an organic substituent containing from 1 to 10 carbon atoms and from 0 to 5 hetero atoms wherein the total number of carbon and hetero atoms in all R^1 substituents of said compound is no more than 15; and R^4 represents a hydrogen or an organic substituent containing from 1 to 10 carbon atoms; provided that when R is -CHO, R^4 is hydrogen, and n=1, R^1 is not o-methoxy; further provided that said formulation does not include a heat resistant clay material, as a preservative for paint.

8. Use of one or more compounds having the formula (1) wherein R represents $-CH_2OH$ or -CHO; n is an integer from 0 to 3; each R^1 independently represents -OH or an organic substituent containing from 1 to 10 carbon atoms and

from 0 to 5 hetero atoms wherein the total number of carbon and hetero atoms in all R^1 substituents of said compound is no more than 15; and R^4 represents a hydrogen or an organic substituent containing from 1 to 10 carbon atoms as a mildewicide in paint and/or wood preservative products.

9. Use of one or more compounds having the formula (1), wherein R represents $-CH_2OH$ or -CHO; n is an integer from 0 to 3; each R^1 independently represents -OH or an organic substituent containing from 1 to 10 carbon atoms and from 0 to 5 hetero atoms wherein the total number of carbon and hetero atoms in all R^1 substituents of said compound is no more than 15; and R^4 represents a hydrogen or an organic substituent containing from 1 to 10 carbon atoms; provided that said formulation does not include a heat resistant clay material or a copper-based component, as an antifoulant in paints and/or wood preservative products.

10. Use according to any one of the claims 6-9 wherein the compound having formula (1) is cinnamic aldehyde, coniferyl aldehyde, and/or alpha hexyl cinnamic aldehyde.

11. A paint or wood preservative formulation comprising a bioactive compound selected from the group consisting of coniferyl aldehyde and alpha hexyl cinnamic aldehyde.

12. A paint or wood preservative formulation comprising one or more bioactive compounds having the formula (1) in the amount of 0.5 to 5 vol. %, wherein R represents $-CH_2OH$ or -CHO; n is an integer from 0 to 3; each R^1 independently represents -OH or an organic substituent containing from 1 to 10 carbon atoms and from 0 to 5 hetero atoms wherein the total number of carbon and hetero atoms in all R^1 substituents of said compound is no more than 15; and R^4 represents a hydrogen or an organic substituent containing from 1 to 10 carbon atoms,

13. A process for controlling or preventing fouling on a hull of a boat, comprising treating said hull with a formulation comprising one or more bioactive

AMENDED SHEET (ARTICLE 19)

compounds having formula (1), wherein R represents $-CH_2OH$ or -CHO; n is an integer from 0 to 3; each R^1 independently represents -OH or an organic substituent containing from 1 to 10 carbon atoms and from 0 to 5 hetero atoms wherein the total number of carbon and hetero atoms in all R^1 substituents of said compound is no more than 15; and R^4 represents a hydrogen or an organic substituent containing from 1 to 10 carbon atoms, said formulation does not include a copper-based component.

14. A process for controlling or preventing fouling on a hull of a boat according to claim 13, wherein said bioactive compound is cinnamic aldehyde, coniferyl aldehyde, or alpha hexyl cinnamic aldehyde

15. A process for controlling or preventing fouling on a hull of a boat according to claim 13 or 14, wherein said formulation comprising 0.5 to 5 vol. % of the bioactive compound.

16. A paint or wood preservative formulation comprising a bioactive compound selected from the group consisting of cinnamic aldehyde, coniferyl aldehyde and alpha hexyl cinnamic aldehyde provided that said formulation does not include a heat resistant clay material or a copper-based component.

AMENDED SHEET (ARTICLE 19)

INTERNATIONAL SEARCH REPORT

tional Application No
/US 95/17048

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 C09D5/14 C09D5/16 B27K3/38 A01N35/02 A01N31/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 C09D B27K A01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	DATABASE WPI Section Ch, Week 9249 Derwent Publications Ltd., London, GB; Class A60, AN 92-403352 XP002003568 & JP,A,04 300 801 (NIPPON PAINT CO LTD) , 23 October 1992 see abstract --- -/--	1,2,4,6,7,9,10

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
22 May 1996	05.06.96

Name and mailing address of the ISA	Authorized officer
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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